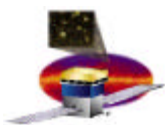


GLAST Large Area Telescope Calorimeter Subsystem

5.3 CDE Manufacturing

Didier Bédérède Project Manager
Philippe Bourgeois System Engineer
CEA Saclay/ DSM/DAPNIA

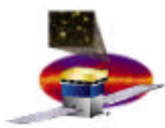
didier.bederede@cea.fr
pbourgeois@cea.fr



CEA responsibilities

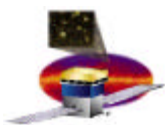
Design and development of the CDE including :

- CDE process specification (written & sent for call for tender Feb'03)
- shared procurement, with the U.S., of DPDs to a common specification (1800 DPD from CEA–Hamamatsu-France proposition Mar'03)
- DPD testing (done for EM-DPDs)
- procurement of DPD wires, attachment and testing of the PDA (diode-cable assemblies),
- bonding of PDA to the Crystals and process qualification,
- procurement of wrapping material, crystal wrapping, and process qualification,
- acceptance testing of finished CDE

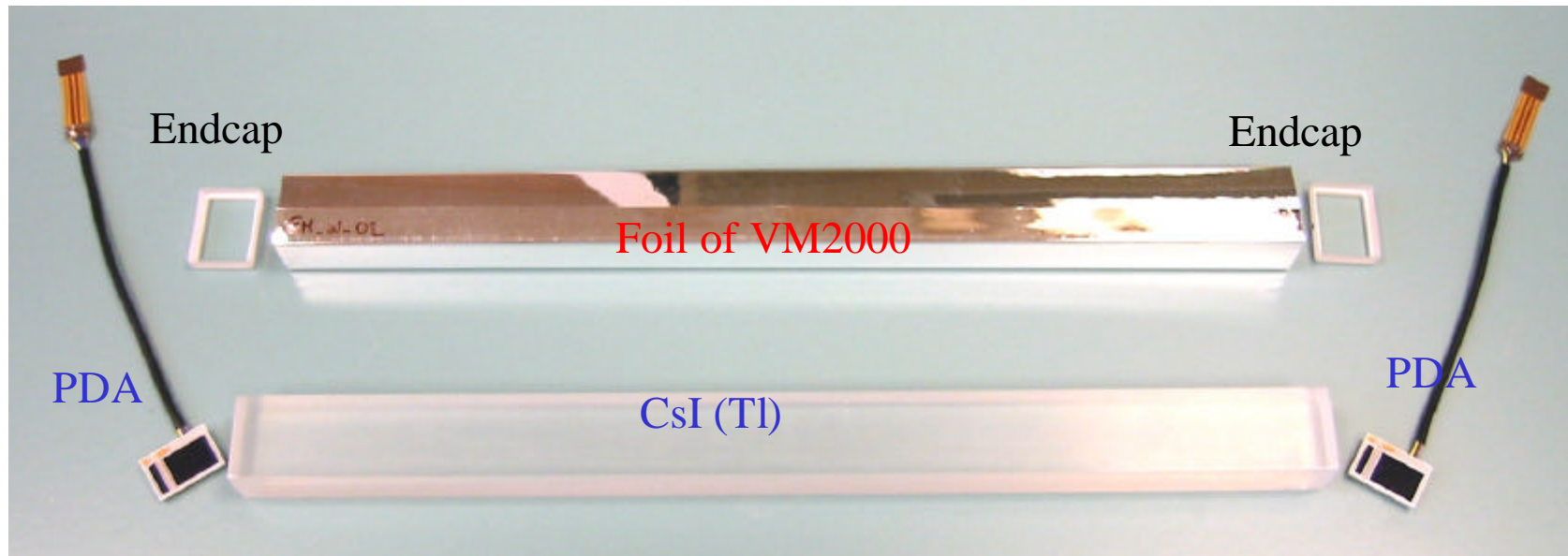


Program status

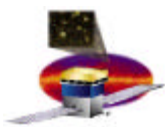
- ❑ **LoA between NASA and CNES**
 - final draft approved by both parties, almost signed
- ❑ **MoA between SLAC, NRL, CEA:**
 - signed in Jan'03
- ❑ **Financial agreement between CNES and CEA:**
 - budget & manpower profiles approved in Nov'02
 - new CNES financial situation: participation to GLAST recommended to the President, but cost-capped
- ❑ **14 EM-CDEs delivered to NRL in Dec'03**
 - they meet the specifications & performance
 - bonding on DPD (epoxy window) & tooling design demonstrated
 - packing concept evaluated
 - DPD evaluation failed (epoxy window at low T + pin corrosion) **DPD** **new**
 - flex changed to wires at the CAL level
- ❑ **present activities**
 - evaluation of the new DPD, new PDA and new PDA bonding
 - placing contracts for the FM PDA, CDE, GSE, & various containers



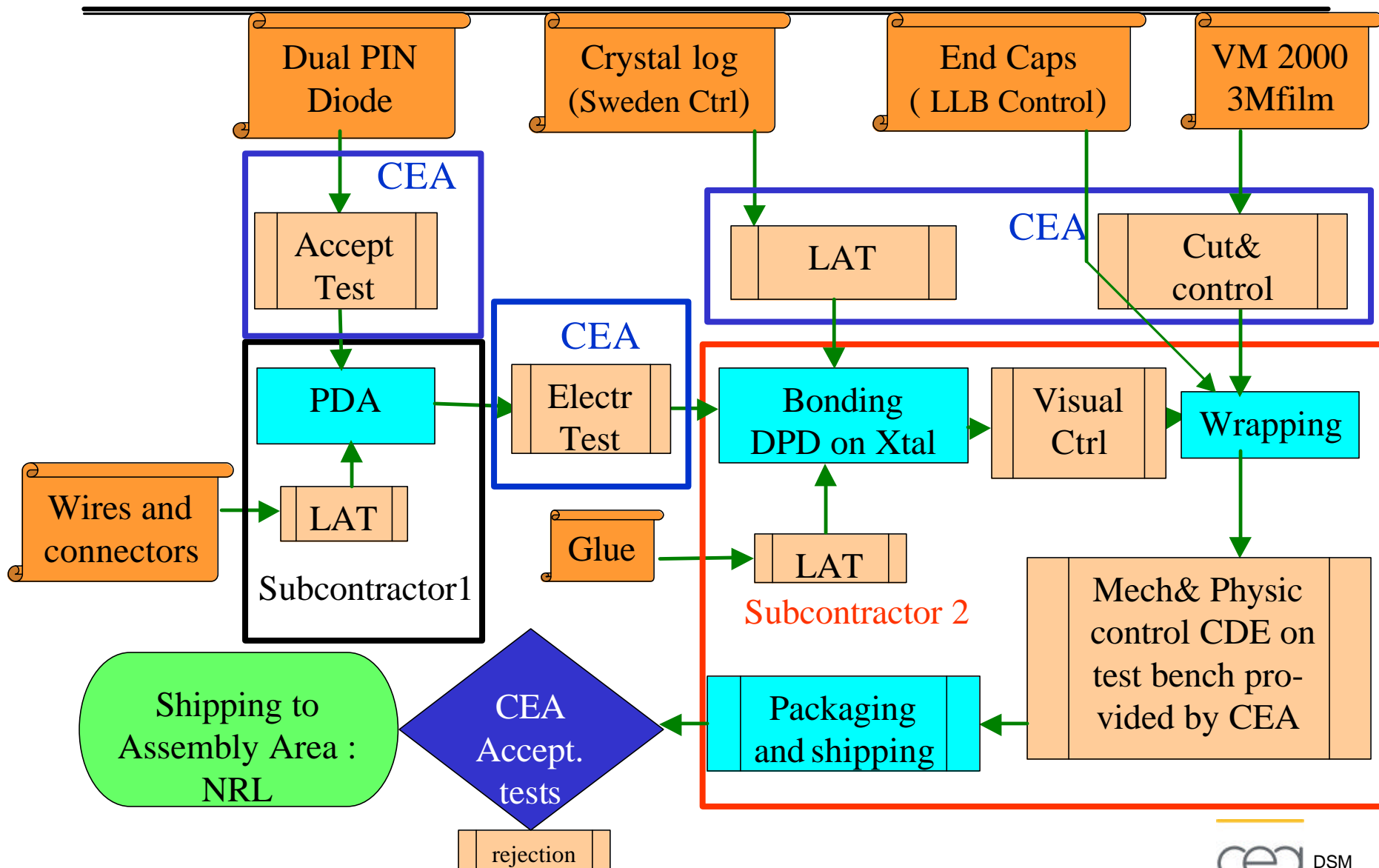
CDE Overview

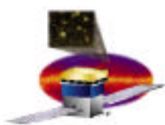


- ❑ a CDE consists of :
 - 1 cristal log of Csl doped with Thallium provided and tested by Sweden
 - 2 PDA (DPD with wires), one bonded to each end
 - wrapping consisting of one molded foil of VM2000 and 2 white endcaps provided and controlled by LLR



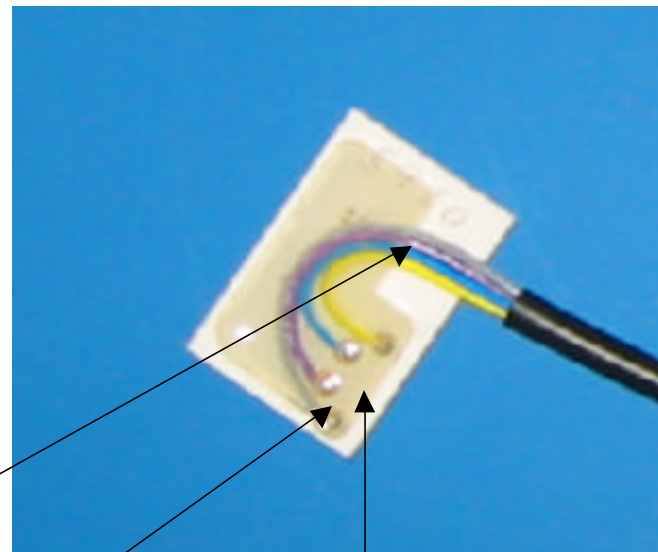
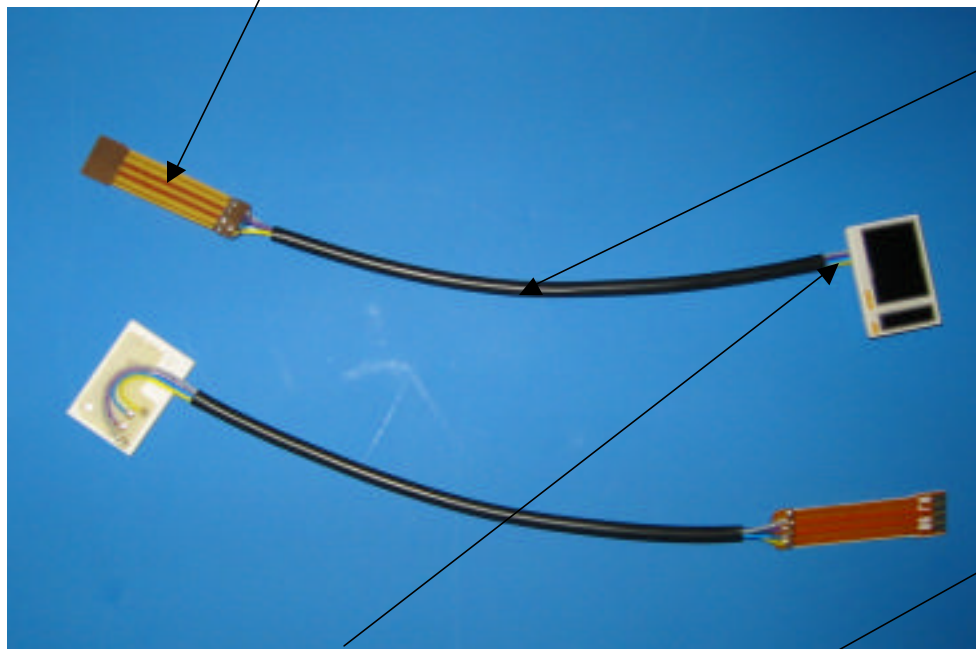
Manufacturing Plan



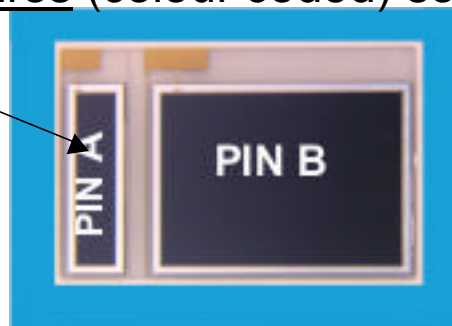


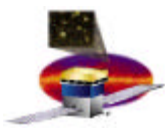
PDA overview

PDA_{fr} = Connector for all French acceptance tests + Protective sleeve + PDA



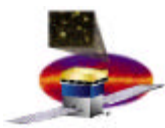
PDA = Dual Pin Diode + 4 wires (colour coded) soldered on pins+ staking



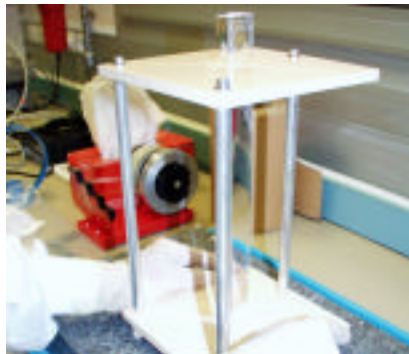


PDA manufacturing plan

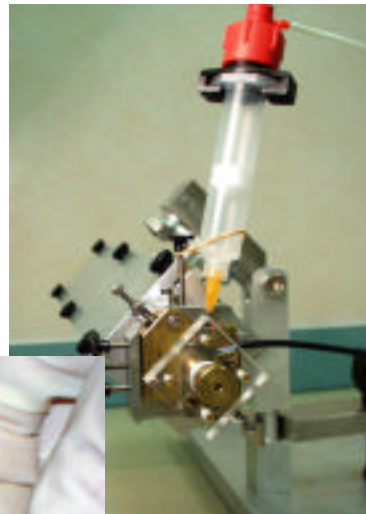
- ❑ Because of the short schedule: wire procurement before contract (> 8 weeks to manufacture)
- ❑ Contract Order: foreseen May 21
 - Call for tender : done (6 companies interested)
 - Sending specifications to selected companies (mid March)
 - Answers from the companies: (end April)
 - Opening letters and ask for additional information
 - Write & sign the contract and place the order
- ❑ Preparation & training (molding tools, encapsulant product...) 7 weeks
- ❑ Manufacturing lot 1 of 264 PDA (begin. July to begin. Aug)
- ❑ Manufacturing lot 2 of 240 PDA (in August)
- ❑ Manufacturing lots 3 to 20 (240 PDA /2 weeks)



PDA-Crystal Bonding Process Overview

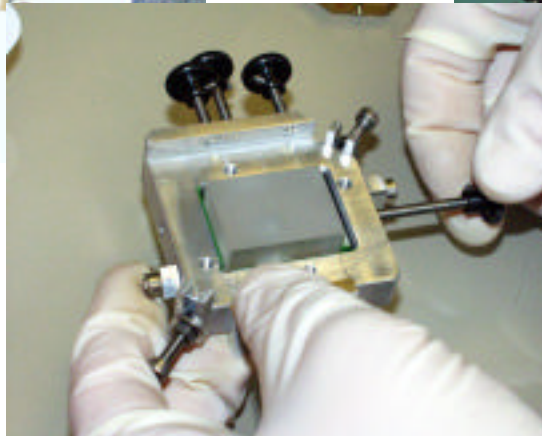


**End face
polishing**

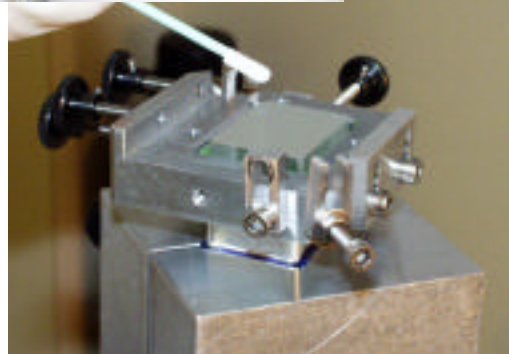


Mold tooling & Glue injection

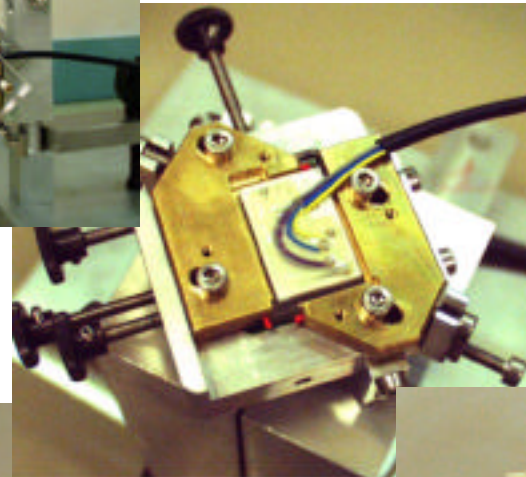
**Support
tooling**



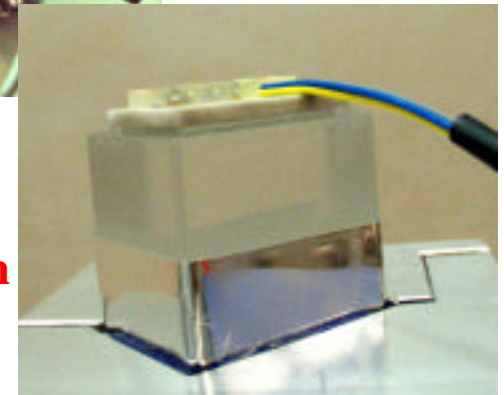
**Primer
deposition**

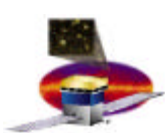


**Polymerisation
time = 7 days**



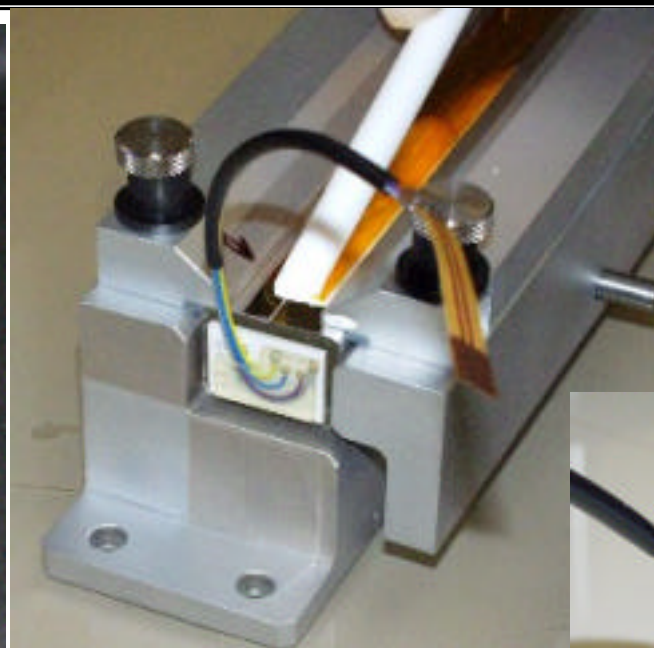
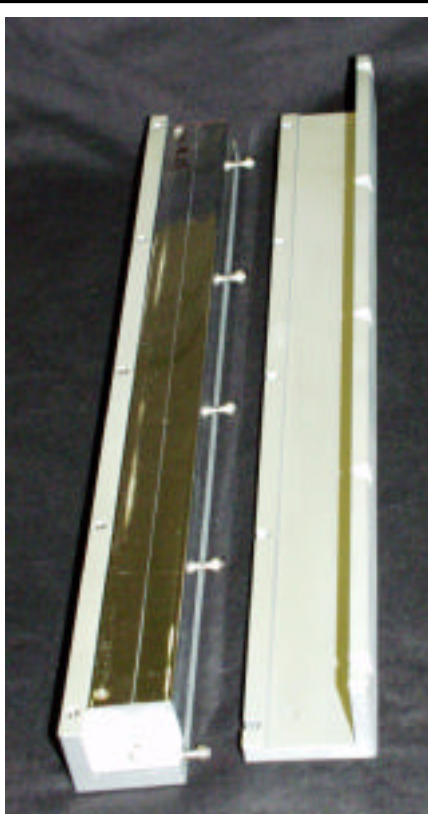
**Mold removal
after 24 hours**





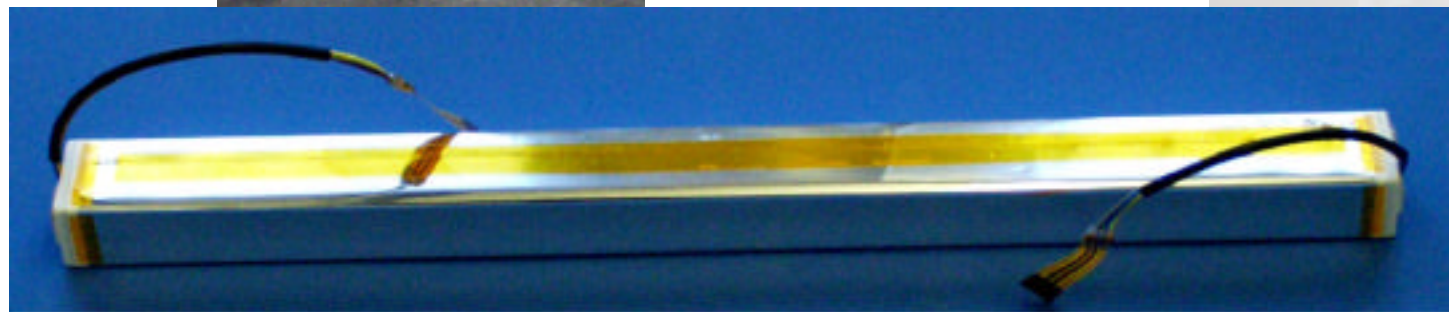
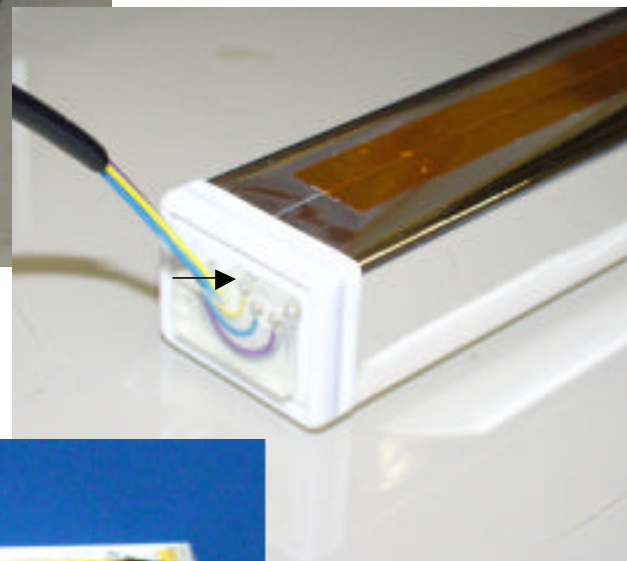
Wrapping overview

**VM2000
foil shaped
around a
kernel at
120°C**

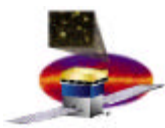


**Mounting of the end
cap around DPD**

**VM2000 foil
wrapped and
pasted**

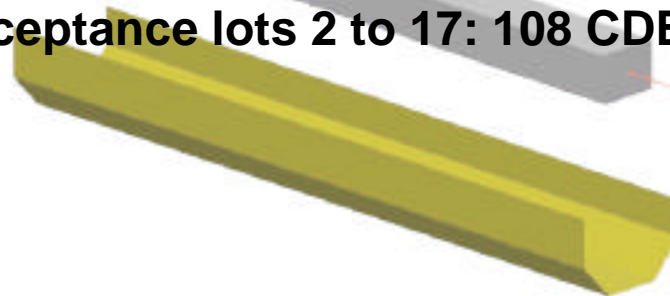


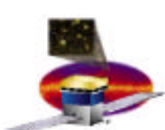
**Wrapped
CDE**



CDE manufacturing plan

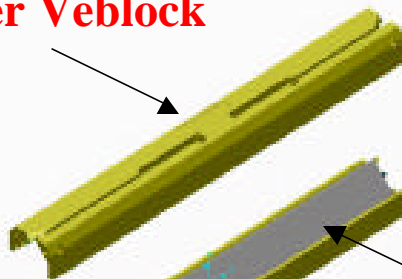
- ❑ Same manufacturer does bonding & wrapping
- ❑ Order **foreseen May 26**
 - Call for tender : **done** (6 companies interested)
 - Sending specifications to selected companies: **done Feb. 13**
 - Answers from the companies: **March 28**
 - Opening letters and ask for additional information **< 2 weeks**
 - Company selection, presentation of documents to committee **on 20 May**
 - Write & sign the contract and place the order **10 days**
- ❑ Procurement of toolings to manufacture 60 CDE/week, process practice & tuning on CEA tooling, tests on mini-Xtal, tests of 12 CDE: **3 months**
- ❑ Manufacturing&acceptance lot 1: 120 CDE in 4 weeks **in Sept**
- ❑ Manufacturing&acceptance lots 2 to 17: 108 CDE/2 weeks **Mid May '04**





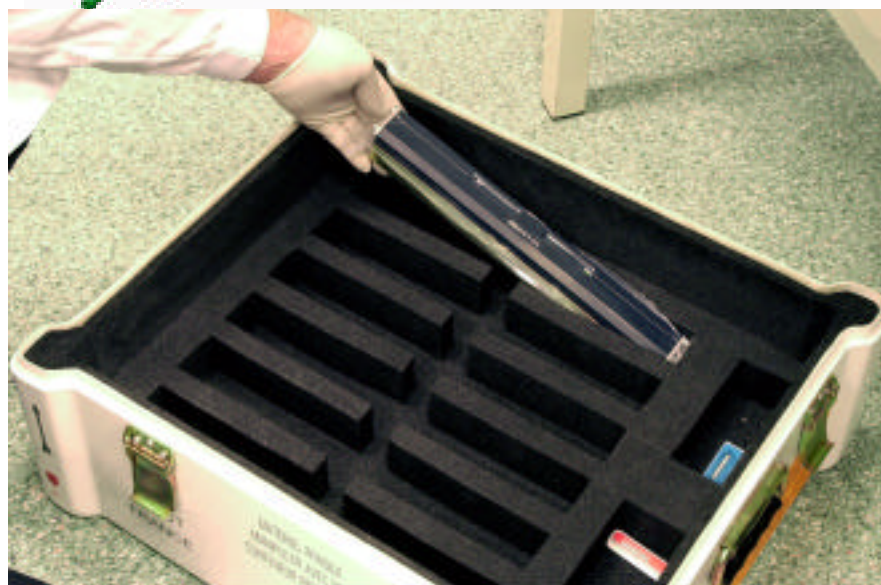
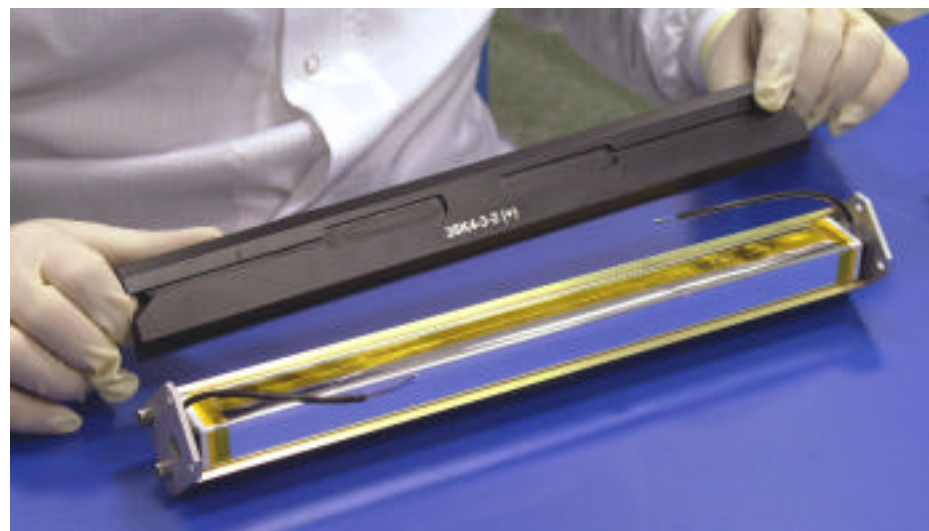
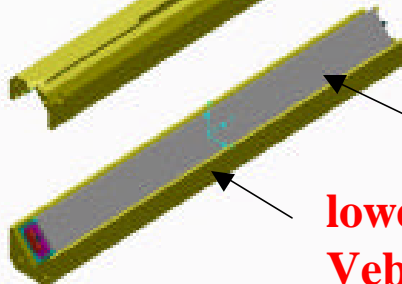
CDE packing & shipping

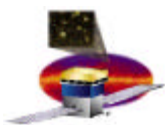
Upper Veblock



CDE

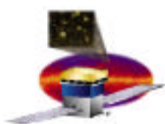
lower Veblock





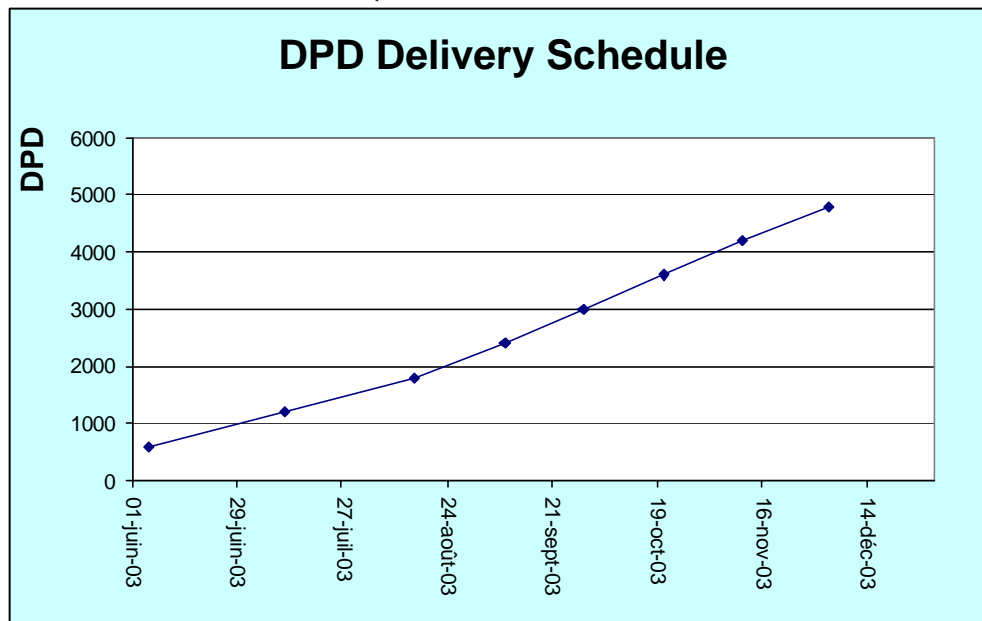
CDE System/Verification plan

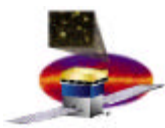
- ❑ **EVALUATION: characteristics and margin studies**
 - **DPD S8576-01 (Silicone window, Lead tinning):**
 - 11 S8576 with Silicone encapsulant
 - 184 S8576-01 (DPD pre-FM-series)
 - **PDA (solder, staking, wires):** DPD pre-series
 - **Bonding (tooling, process):** DPD pre-series + mini Xtal
- ❑ **QUALIFICATION: Specification requirements**
 - **DPD S8576-01**
 - **Tinned ceramic:** 1% by lot
 - **Die:** 5 by wafer lot
 - **Assembly:** 10% 1st Delivery Lot (+ screening)
 - **PDA (Plan TBC)**
 - **Bonding (tooling, process):** DPD pre-series + mini Xtal
 - **CDE :** DPD pre-series+ Xtal pre-series



DPD procurement status

- ❑ New DPD version: S8576-01
- ❑ Order shared between NRL (5 lots) and CEA (3 lots)
- ❑ Order in place before evaluation (driven by schedule)
- ❑ Delivery of a pre-series:
 - 184 with the silicone resin encapsulant
 - 20 without encapsulant (backup encapsulant study)
- ❑ Delivery by Lot of 600 DPD: Qualification on 1st lot





DPD Qualification plan

❑ Philosophy:

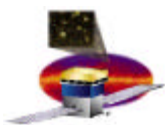
- Qualification on 1 lot associated to a screening
- Qualification on 60 of 1st Delivery Lot in addition to its Acceptance test

❑ Main tests

- Lead solderability (1 DPD)
- Moisture intake (168h, 50°C, 50%RH) (6 DPD)
- Steady-state life (1000h, 60°C) (22 DPD)
- Thermal cycle (60c, -30 to 50°C) (10 DPD)
- Radiation testing (10krad) (3 DPD)

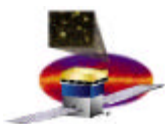
❑ Associated control

- Dark current & Green photosensitivity
- Delamination, crack
- Destructive Physical analysis



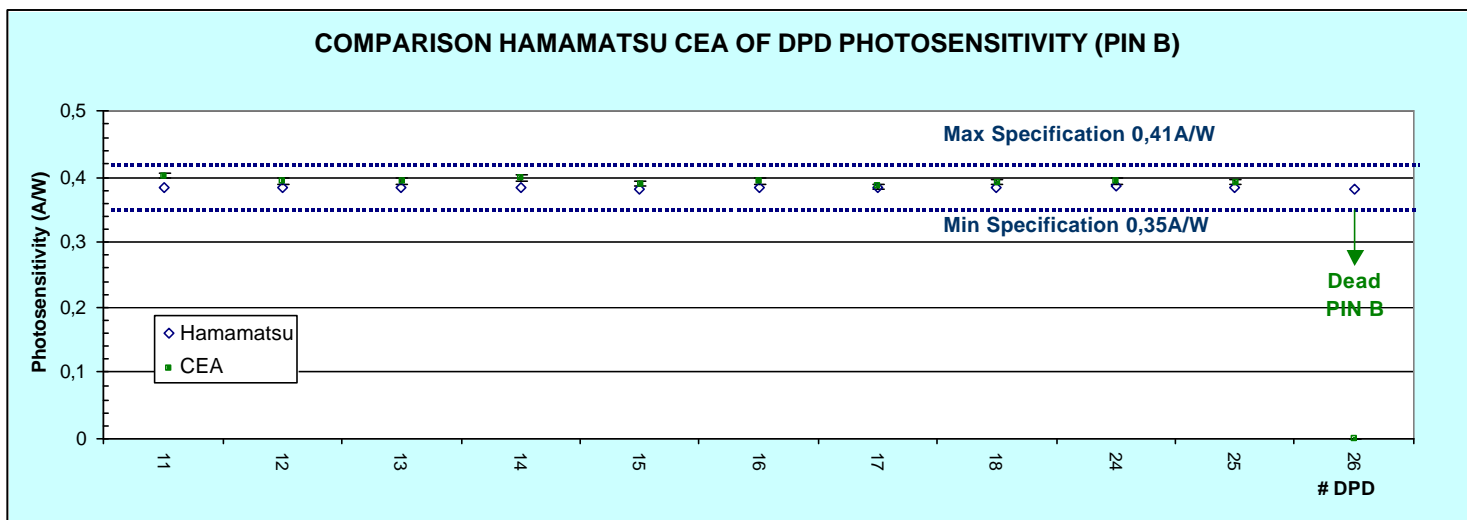
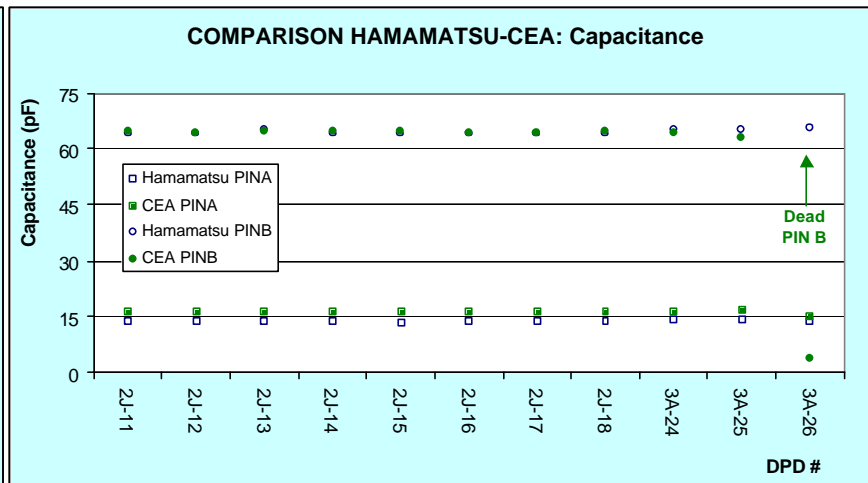
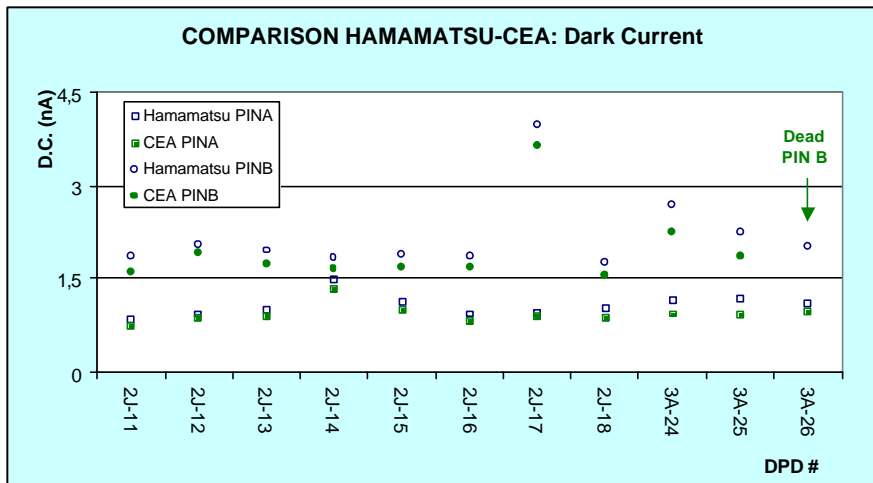
DPD Acceptance Test (1)

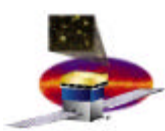
- ❑ Receiving inspection (with Hamamatsu representative)
 - **Packaging and sensor inspections** (shock, humidity, temp.)
 - **DPD recorded parameters vs the acceptance limits**
 - D.C., Capacitance, Sensitivity
- ❑ Control (within 2 weeks at CEA)
 - **100% Visual inspection** (window, leads)
 - ⇒ **refusal of bad DPDs**
 - **Sampling > 10% parameters** (D.C., Capacitance, Sensitivity)
 - ⇒ **Drift production monitoring**
 - ⇒ **Refusal of the delivery lot**



DPD Acceptance Test (2)

□ Acceptance test on the 11 DPD S8576 Silicone window





PDA design

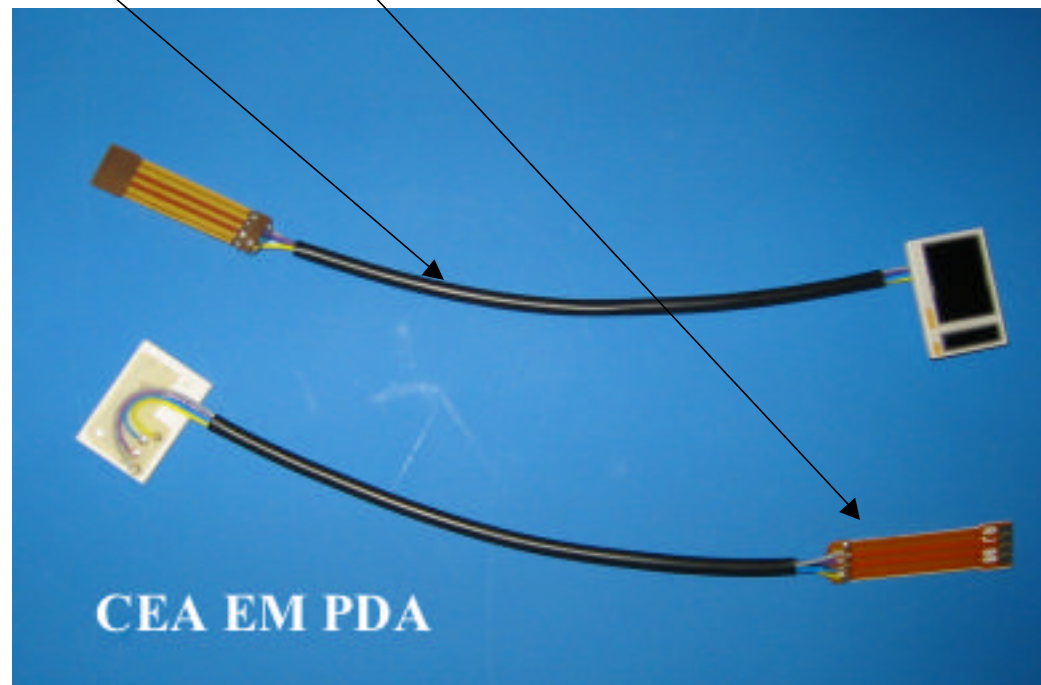
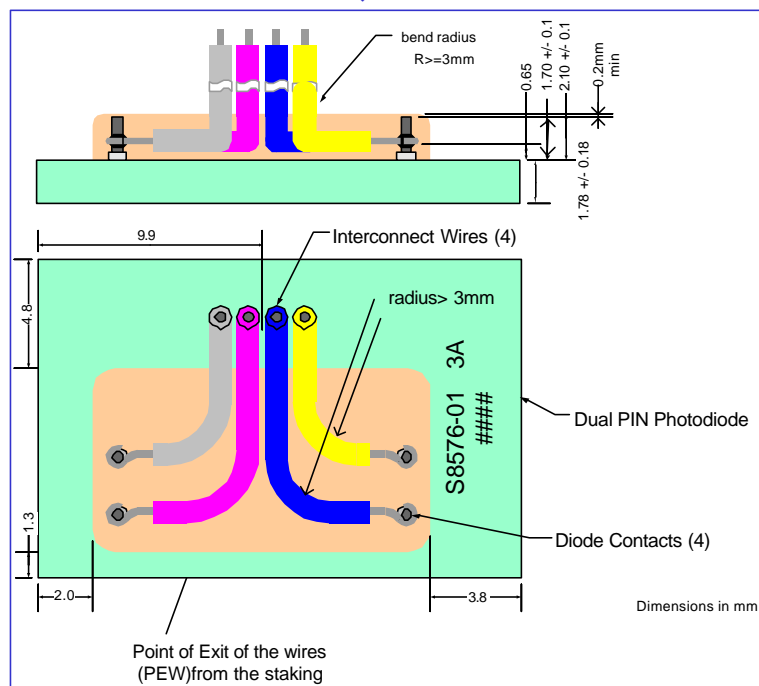
PhotoDiode Assembly: DPD + soldered wires + wires staking on ceramic

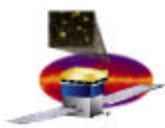
PDAfr: PDA + protective sleeve + connector for CEA test benches

New lead position of S8576-01

New staking mold

New connector





PDA verification plan

❑ Evaluation:

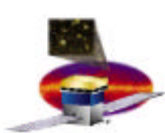
- **Strength of the soldered and staked wires** (1kg requirement)
- **New tinning (SN96Ag4 + 40°C)** study of DPD temperature when soldering
- **Insulation of the 0.2mm staking above the leads** (0.1nA)

❑ Qualification:

- **Spatial components (wires, encapsulant)**
- **Spatial approve Subcontractor**
- **Thermal cycle (60c, -30 to 50°C)** study of lead insulation on bare ceramic

❑ Acceptance test:

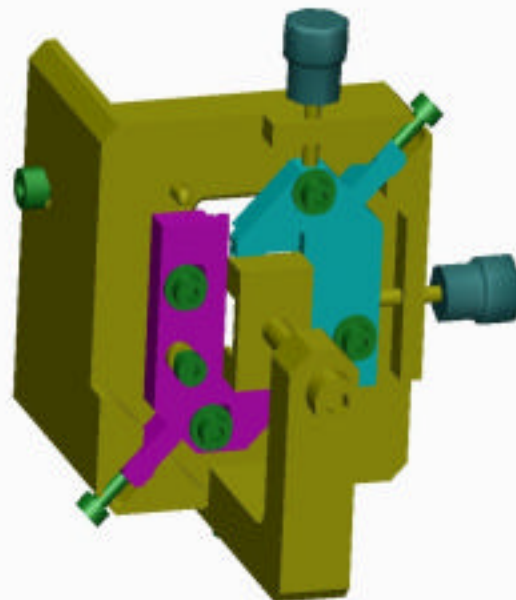
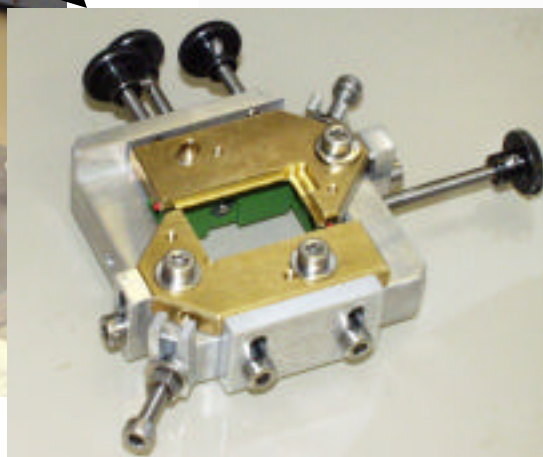
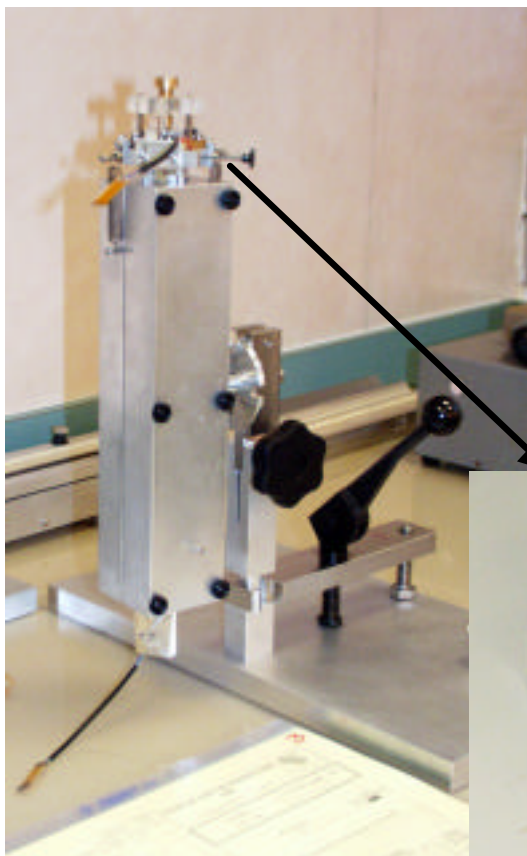
- **100% Electrical** (D.C.)
- **100% Visual** (Solder before staking, window)
- **100% go-no go staking area**
- **100% staking thickness**



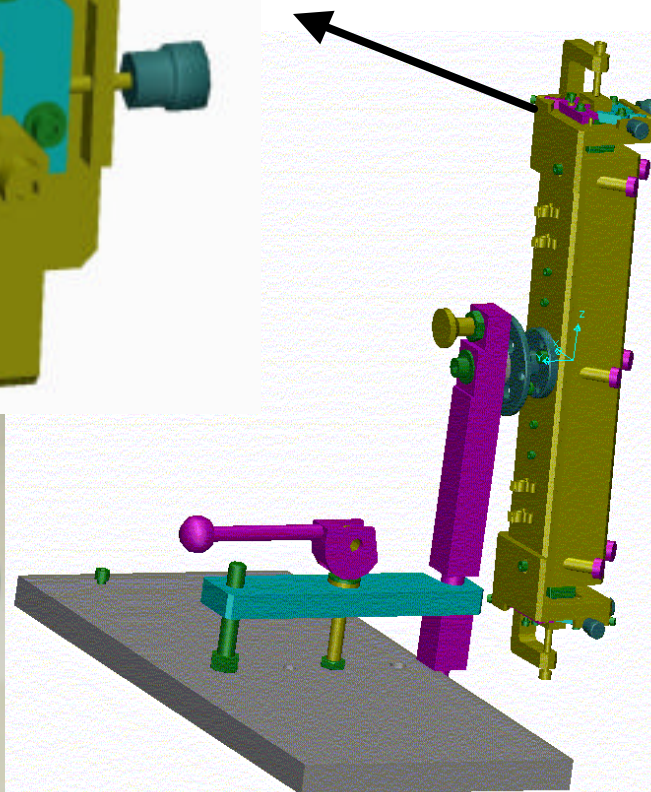
Bonding tooling design

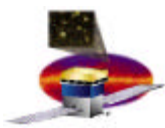
❑ Upgrade of the tooling

EM bonding tooling



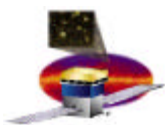
FM bonding tooling





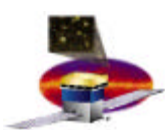
Bonding process verification

- ❑ **Sample: Mini Xtal + PDA at each end**
- ❑ **Evaluation:**
 - **Thermal Cycle** (-30 to 50°C, -38 to 60°C & -45 to 70°C, 30 cycles)
 - **Mechanical Test** (Shearing, shock, pulling)
 - **Optical test** (light yield)
- ❑ **Qualification:**
 - 1. Tooling and procedure**
 - **Thermal Cycle** (-30 to 50°C, 0-30-60 cycles)
 - **Mechanical Test** (only Shearing)
 - **Optical test** (light yield)
 - 2. Sub-contractor**
 - **Same plan**
- ❑ **Acceptance test:**
 - **2 samples every 100 bonding**
 - **100% Visual inspection** (bubble)
 - ⇒ **repair allowed but PDA lost**



Wrapping foils inspection and testing

- ❑ **VM2000 roll Acceptance:**
 - Reflectivity measurement
 - Wrapping of a reference CDE for L.Y. measurement
- ❑ **VM2000 cutting Acceptance:**
 - Clean room environment (Class 100,000)
 - Packaging by 12 sheets (with traceability)
 - 1 sheet every 120 for L.Y. control on ref CDE

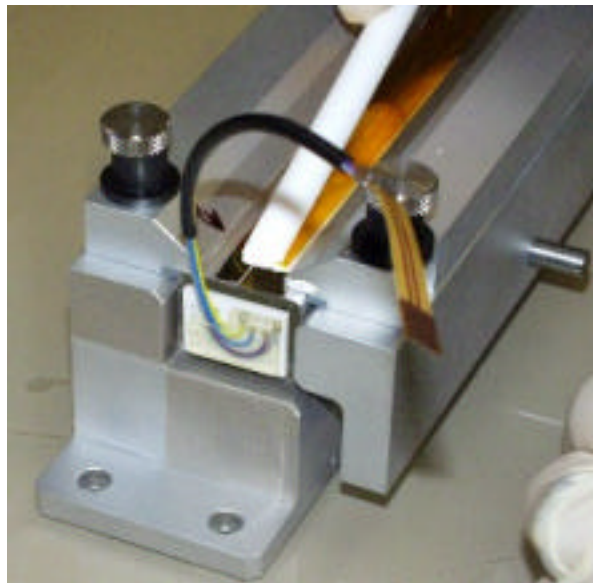


CDE Wrapping Tooling design

- ❑ Based on Swales design and procedure

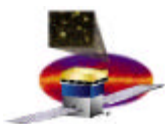
Upgrade of the molding tooling for a better reliability of the sheet position

VM2000 Mold
tooling (120°C, 2h)



Industrialization of the Wrapping tooling

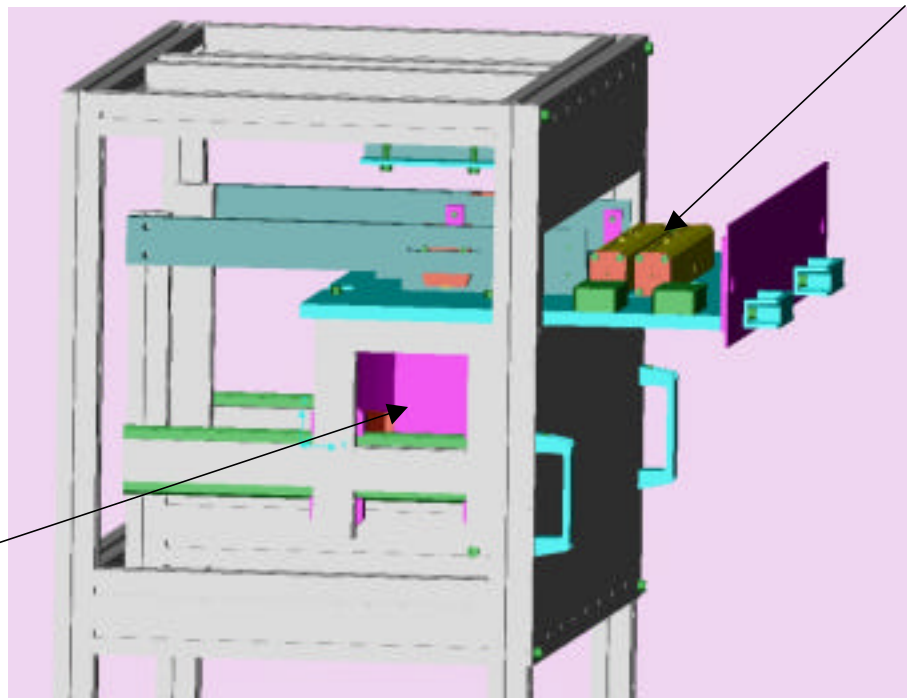
Wrapping
tooling



CDE Verification Plan (1)

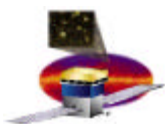
- ❑ **TEST at the subcontractor**
 - **100% mechanical control**
 - **100% PIN B L.Y. and resolution ; PIN B/PIN A ratio**

2 CDE at the time in their V support



Yttrium 1.84MeV γ
radioactive source

BIG (Banc Industrie Glast)

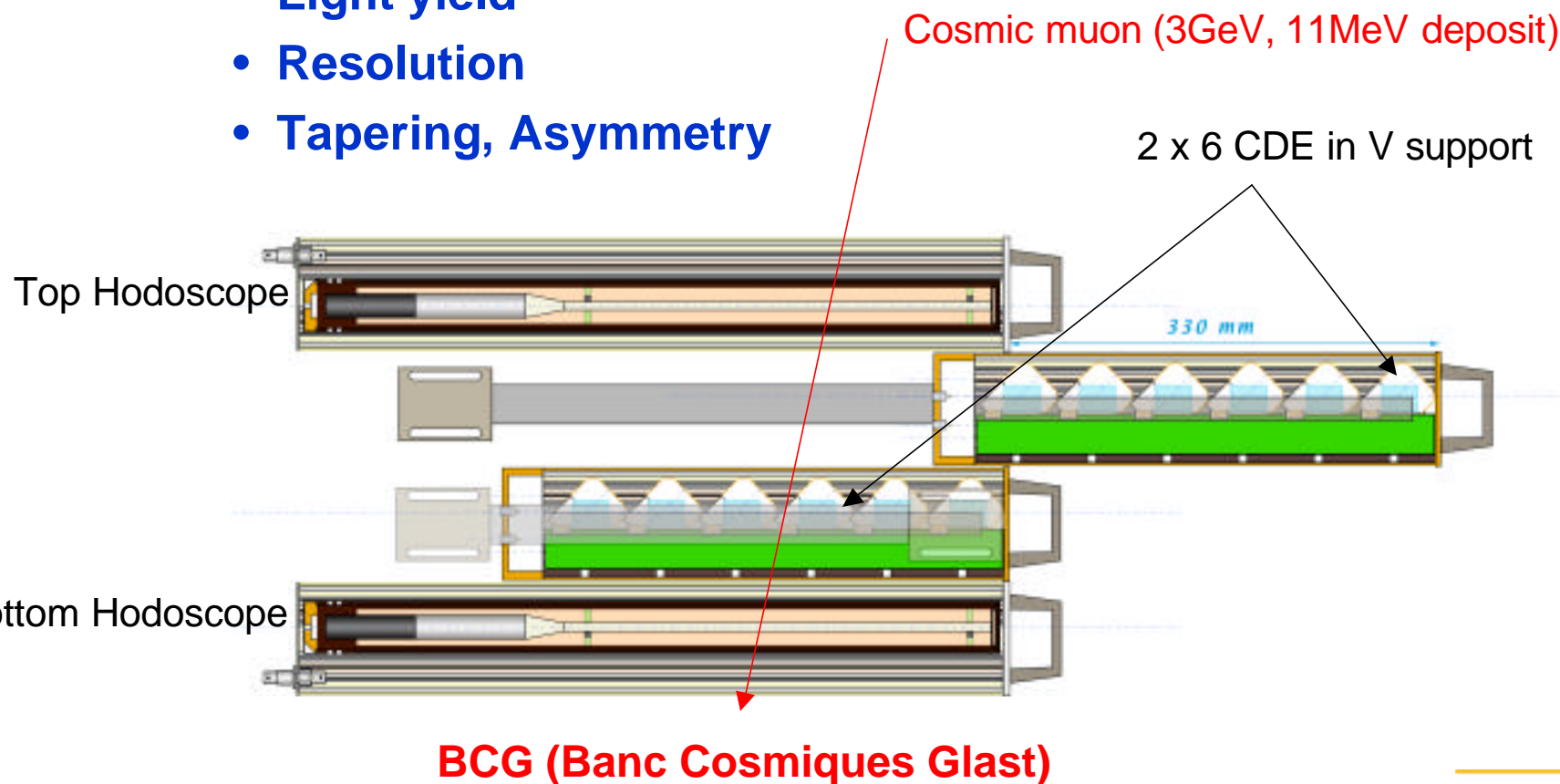


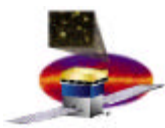
CDE Verification Plan (2)

□ Performance measurements before shipping to NRL

– For both PIN A & B:

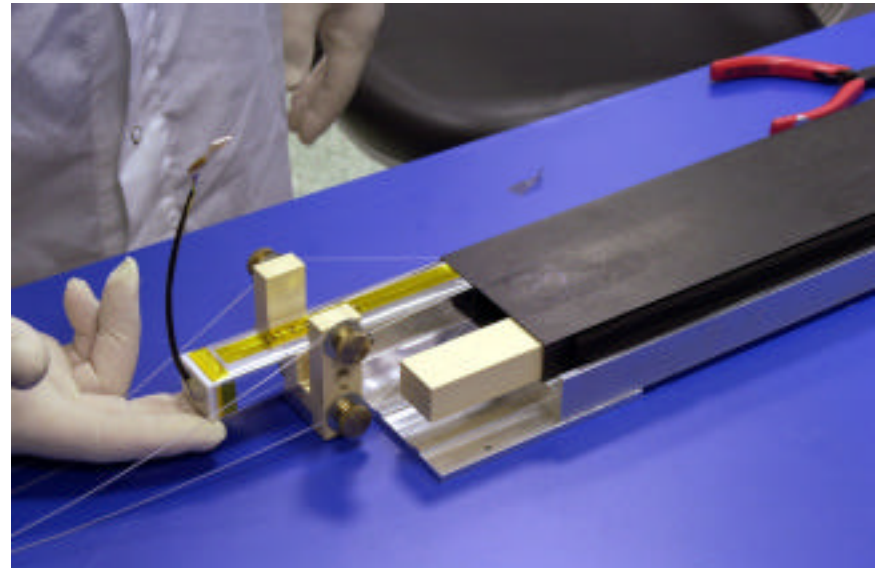
- Light yield
- Resolution
- Tapering, Asymmetry



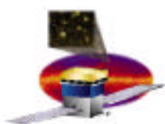


CDE Verification Plan (3)

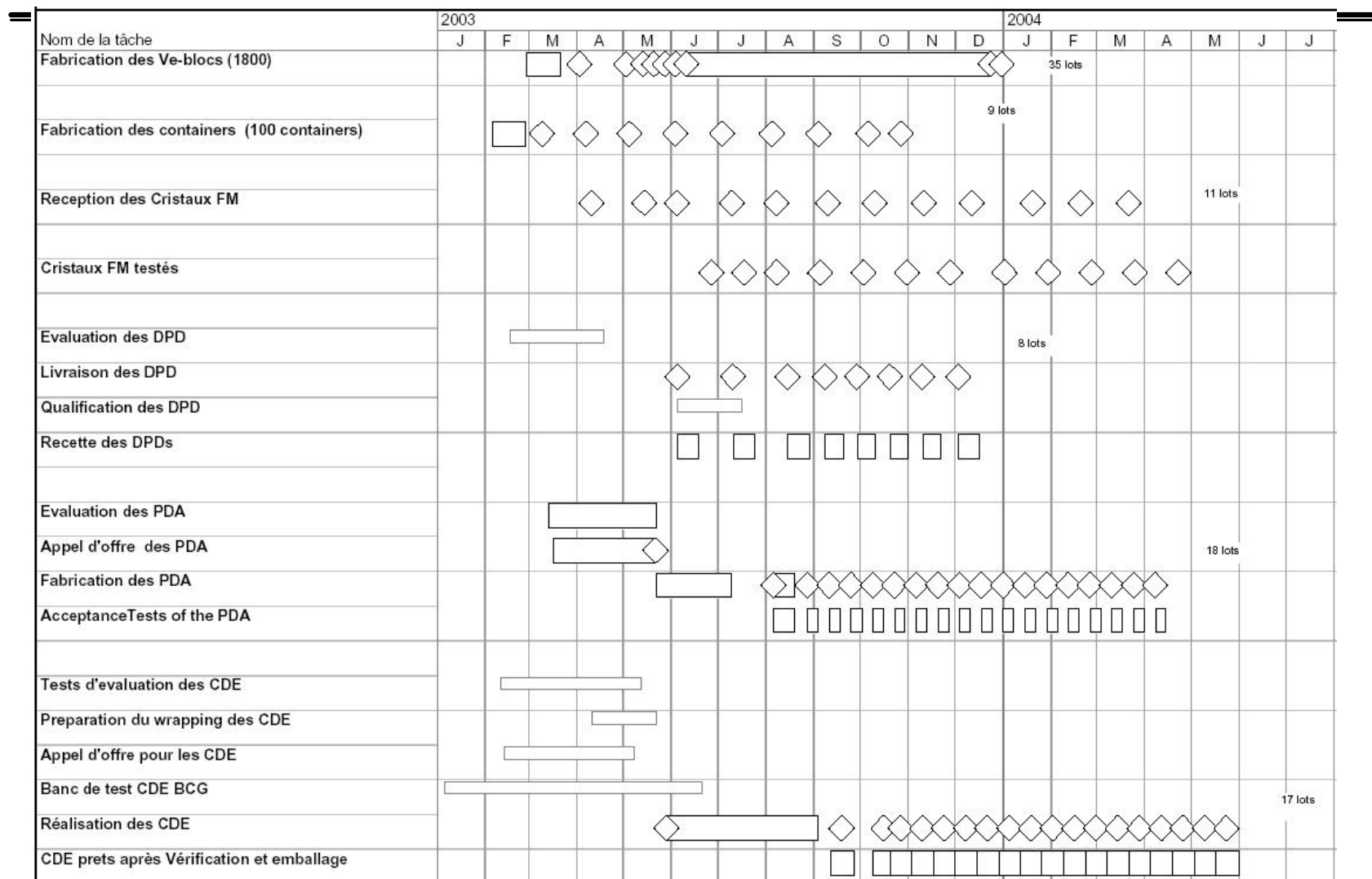
- ❑ **Insertion test before shipping to NRL**
 - **Go no go: Minimum size Cell + 1mm cord stretched by a factor 2**
 - If no go \Rightarrow Go-no go: Mean size Cell
 - **Study of a two pieces Aluminium Alloy Cell**



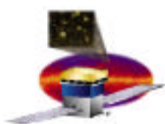
- ❑ **Qualification**
 - **Thermal Cycle** (-30 to 50°C, 0-30-60 cycles)
 - **Vacuum** (-1000mBar in 100s)
 - **Radiation test** (10kRad)



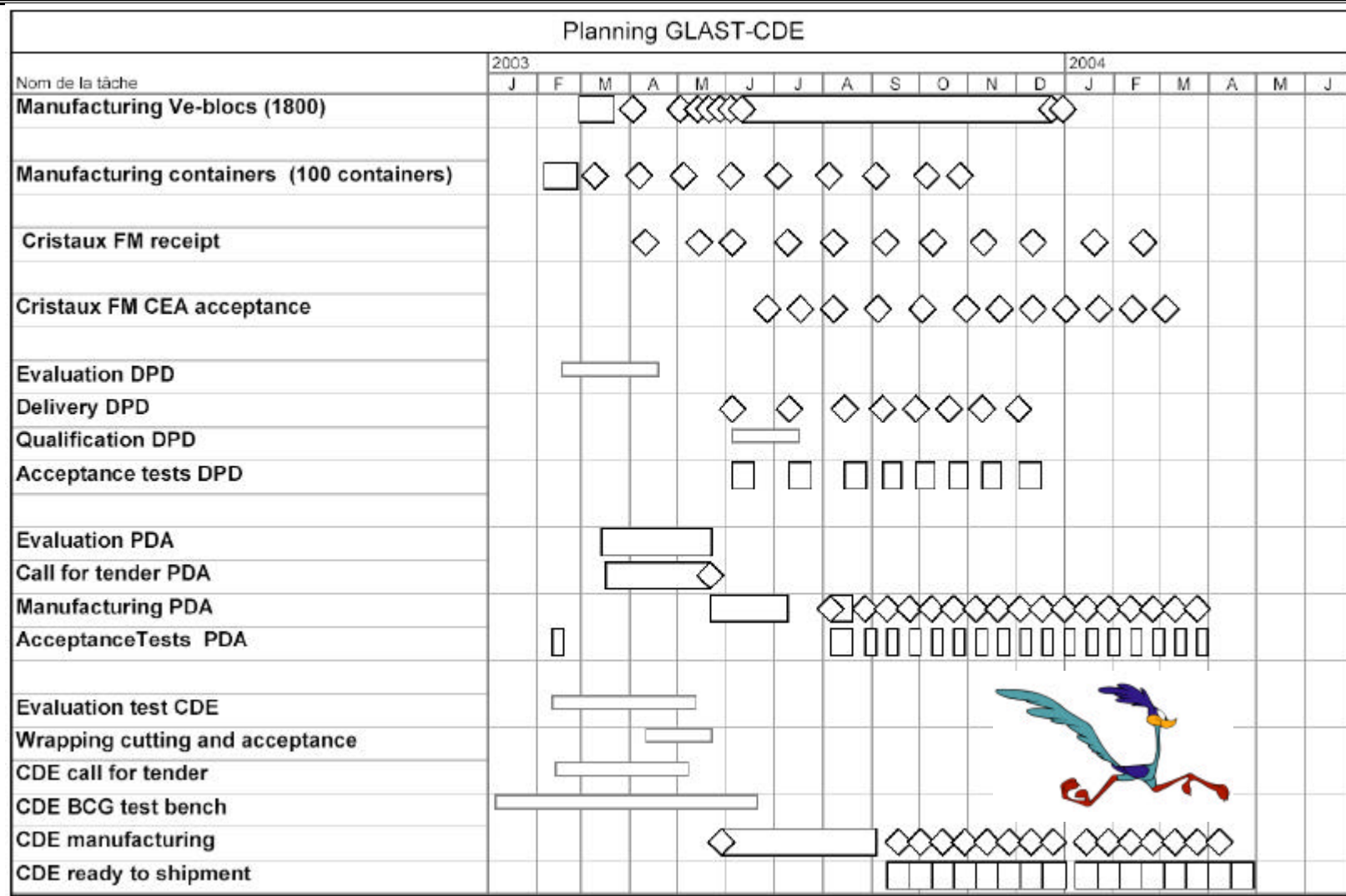
Current manufacturing schedule



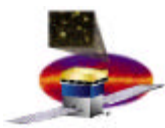
Based on delivery at CEA of 184 eval DPD on April 14 and 1st FM-DPDs on June 6



Increased rate schedule



Manpower & financial impact under study (60 CDE/week)



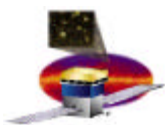
Schedule risks

❑ Current schedule very tight

- assumes successful DPD evaluation, PDA qualification, & bonding qualification
- Market Committee Review (Budget Ministry & CEA) : if review requested ⇒ contract starting date could shift from May 26 to June 20 **Mandatory**
- Manufacturers may be uncomfortable with 3 month preparation time and ask for 4 months **known on March 31**

❑ Increased rate schedule

- Cost impact **evaluated by March 31**
- Rate = 60/week ⇒ last CDE on time
- Rate = 80/week ⇒ FM4 -16 on time



Issues/Concerns

- ❑ **New DPD evaluation**
 - in progress on 10 samples
 - on some of the 184 DPDs starting in April
- ❑ **DPD qualification on 60 DPD of lot 1 (= 600)**
 - many manufactured by then \Rightarrow risk on schedule & cost
- ❑ **PDA qualification of the soldering & staking**
 - on some of the 184 DPDs starting in April
- ❑ **Bonding qualification (concave silicon window)**
 - tests at NRL, 4 being tested at Saclay, more in April
- ❑ **Wrapping : VM2000 ESD properties**
 - in progress at NRL and Goddard
- ❑ **DPD packaging to be improved (in progress)**
- ❑ **No absolute light yield requirement on the Xtal, but on the CDE**
 - Action: L.Y. acceptance tests of Xtals with DPD and sources